CLAIMS

What is claimed is:

1. An equalizer comprising:

a feedforward filter adapted to receive a first input signal and provide a first output signal;

an adaptive coefficient generator adapted to receive the first input signal and a second signal and provide tap coefficients to the feedforward filter;

a slicer adapted to receive a slicer input signal and provide a slicer output signal;

a slicer timing alignment block adapted to receive the slicer input signal and provide a second output signal, wherein the slicer output signal is subtracted from the second output signal to generate an error signal;

a tap timing alignment block adapted to receive the slicer output signal and provide a third output signal;

a first low pass filter adapted to receive the third output signal and the error signal and provide a fourth output signal, wherein the fourth output signal is multiplied with the third output signal to provide a feedback signal which is added to the first output signal to generate the slicer input signal; and

a second low pass filter adapted to receive the error signal and provide a mean square error signal.

2. The equalizer of Claim 1, further comprising a register block adapted to receive the mean square error signal from the second low pass filter and the tap coefficients from the adaptive coefficient generator.

3. The equalizer of Claim 1, wherein a bandwidth estimate is obtained for a communication channel based on correlation coefficient values determined when the slicer output signal is open-circuited and fixed values are provided for the tap coefficients.

4. The equalizer of Claim 1, wherein a channel identification estimation is obtained for a communication channel based on subtracting a second input signal $(r(t)*h(t))$ from the slicer input signal, where $r(t)$ is a random signal, $h(t)$ is an unknown impulse response for the communication channel, and the first input signal is statistically equivalent to $r(t)$, and determining the tap coefficients corresponding to a least mean square optimal set.

5. The equalizer of Claim 4, wherein the slicer output signal is open-circuited.

6. The equalizer of Claim 1, wherein an optical signal-to-noise ratio estimation is obtained for a communication channel based on the mean square error signal, the tap coefficients, and the slicer input signal or based on the tap coefficients.

7. The equalizer of Claim 1, wherein a bit error rate estimation is obtained for a communication channel based on the mean square error signal and the slicer input signal.

8. The equalizer of Claim 1, wherein a chromatic dispersion estimate is obtained by estimating a bandwidth roll-off and utilizing look-up table values.

9. The equalizer of Claim 1, wherein a chromatic dispersion estimate is obtained by computing a spectral response of the feedforward filter and determining a weighted average of a group delay across the frequencies to estimate a group delay variation as a measure of the chromatic dispersion.

10. The equalizer of Claim 1, wherein a polarization mode dispersion estimate is obtained by determining a frequency at which a spectral response is minimal from an estimated power spectral density.

11. The equalizer of Claim 1, wherein the equalizer is a fractionally-spaced linear equalizer which provides a continuous time adaptation for a communication channel.

12. The equalizer of Claim 1, wherein the adaptive coefficient generator time-aligns the error signal with the first input signal.

13. The equalizer of Claim 1, wherein the slicer timing alignment block time-aligns the slicer input signal with the slicer output signal.

14. The equalizer of Claim 1, wherein the tap timing alignment block time-aligns the slicer output signal with a symbol period.

15. The equalizer of Claim 1, wherein the second signal comprises the error signal or the tap coefficients.

16. The equalizer of Claim 1, wherein the second signal comprises the error signal.

17. An equalizer comprising:

means for receiving a first input signal and providing an equalized output signal;

means for receiving the first input signal and providing tap coefficients to the means for providing the equalized output signal;

a slicer adapted to receive a slicer input signal and provide a slicer output signal;

means for generating an error signal based on the slicer output signal;

means for generating a feedback signal, which is summed with the equalized output signal to generate the slicer input signal; and

means for generating a mean square error signal based on the error signal.

18. The equalizer of Claim 17, further comprising means for storing the tap coefficients and the mean square error signal.

19. The equalizer of Claim 17, wherein the equalizer is employed to determine at least one of a bandwidth estimate, a channel identification estimate, a signal-to-noise ratio estimate, a chromatic dispersion estimate, and a polarization mode dispersion estimate for a communication channel associated with the equalizer.

20. The equalizer of Claim 17, wherein the equalizer is a fractionally-spaced transversal filter with decision feedback and least mean square-based adaptation to provide a continuous time adaptation for a communication channel.

21. A method for providing a bandwidth estimate for a communication channel using an equalizer, the method comprising:

switching off a slicer of the equalizer;

setting tap coefficients of a feedforward filter of the equalizer to fixed values; and

calculating correlation coefficient values.

22. The method of Claim 21, wherein the correlation coefficient values are calculated based on the following equation, $\tilde{c}_i \approx E(p(t) \cdot p(t-i-\tau')), 0 \leq i \leq N$,

where N is the number of tap coefficients, E is the expected value operator, and p is an input signal received by the feedforward filter having eight multipliers.

23. The method of Claim 21, further comprising:

changing one or more of the values for the tap coefficients; and

calculating a set of correlation coefficient values.

24. The method of Claim 23, further comprising calculating a power spectral density based on the set of correlation coefficient values.

25. The method of Claim 24, wherein the power spectral density calculation utilizes a windowing function.

26. The method of Claim 24, wherein the power spectral density calculation utilizes a windowing function.

27. The method of Claim 21, wherein the set of correlation coefficient values are calculated based on the following equation, $\tilde{c}_{i,j} \approx E(p(t-j\cdot\tau)\cdot p(t-i\cdot\tau')), 0\le i\le N, 0\le j\le N$, where N is the number of tap coefficients.

28. The method of Claim 21, further comprising changing timing control ratios of the equalizer to calculate further sets of correlation coefficient values.

29. A method for providing a channel identification estimate for a communication channel using an equalizer, the method comprising:

receiving a first input signal by a feedforward filter of the equalizer, wherein the feedforward filter provides a first output signal;

receiving a second input signal denoted as r(t)*h(t), where h(t) represents an unknown channel impulse response for the communication channel and r(t) represents a random signal;

subtracting the second input signal from the first output signal to provide a difference signal; and

determining adaptively a set of tap coefficients for the equalizer that minimizes the energy of the difference signal within the equalizer.

30. The method of Claim 29, wherein r(t) is approximately statistically equivalent to the first input signal.

31. The method of Claim 30, wherein r(t) is generated using a pseudo-random binary sequence or additive white Gaussian noise.

32. The method of Claim 29, wherein the set of tap coefficients are from the feedforward filter and decision feedback circuits of the equalizer.

33. The method of Claim 29, wherein the set of tap coefficients correspond to a least mean square set of optimal tap coefficients that regenerate the unknown channel.

34. A method for providing an optical signal-to-noise ratio estimate for a communication channel using an equalizer, the method comprising:

calculating an unbiased electrical signal-to-noise ratio based on an input signal to a slicer of the equalizer and a mean square error signal generated by the equalizer;

calculating an electrical signal-to-noise ratio based on the unbiased electrical signal-to-noise ratio and tap coefficients of a feedforward filter of the equalizer; and

calculating the optical signal-to-noise ratio based on the electrical signal-to-noise ratio.

35. The method of Claim 34, wherein the optical signal-to-noise ratio is the square root of the electrical signal-to-noise ratio.

36. A method for providing a bit error rate estimate for a communication channel using an equalizer, the method comprising:

calculating an unbiased electrical signal-to-noise ratio based on an input signal to a slicer of the equalizer and a mean square error signal generated by the equalizer; and

calculating the bit error rate based on the unbiased electrical signal-to-noise ratio.

37. The method of Claim 34, wherein the bit error rate is calculated using the following equation, $BER = Q(0.5 \cdot \alpha \cdot \sqrt{SNR_{e,u}})$

where α is a constant.

38. A method for providing an optical signal-to-noise ratio estimate for a communication channel using an equalizer, the method comprising:

calculating an electrical signal-to-noise ratio based on tap coefficients of the equalizer; and

calculating the optical signal-to-noise ratio based on the electrical signal-to-noise ratio.

39. The method of Claim 38, wherein the electrical signal-to-noise ratio is calculated using the following equation,

$$SNR_e = \frac{(\sum_{i=0}^{N} c_i^2)}{\frac{1}{\sum_{i=0}^{N} c_i + f - 1} - 1},$$ where f is the frequency and N is the number of tap coefficients.

40. A method for providing a chromatic dispersion estimate for a communication channel using an equalizer, the method comprising:

determining a bandwidth roll-off within the communication channel; and

estimating the chromatic dispersion by utilizing a look-up table and the results of the bandwidth roll-off determination.

41. A method for providing a chromatic dispersion estimate for a communication channel using an equalizer, the method comprising:

calculating a spectral response of a feedforward filter of the equalizer;

determining a group delay at discrete frequencies for a frequency spectrum; and

determining a weighted average of the group delays to estimate a group delay variation as a measure of the chromatic dispersion.

42. The method of Claim 41, wherein the spectral response is determined from the following equation, $P(\omega)=\sum_{i=0}^{N} c_i \cdot e^{j \cdot i \cdot \omega \cdot \tau}$, where N is the number of tap coefficients.

43. The method of Claim 41, wherein the determining of the group delay includes a low end and a high end of the frequency spectrum.

44. A method for providing a polarization mode dispersion estimate for a communication channel using an equalizer, the method comprising:

determining a frequency f_0 at which a spectral response is minimal; and

calculating the polarization mode dispersion based on the frequency f_0.

45. The method of Claim 44, wherein the polarization mode dispersion is calculated using the following equation,

$$\tau_{pmd} = \frac{1}{2 \cdot f_0} \quad .$$